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IS : 11185 - 1984
(Reaffirmed 1998)

Indian Standard

**SPECIFICATION AND
TECHNICAL SUPPLY CONDITIONS FOR
HOT-ROLLED AND FORGED STEEL BARS FOR
USE IN MACHINE TOOL INDUSTRY**

(First Reprint NOVEMBER 2000)

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BUREAU OF INDIAN STANDARDS

MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG

NEW DELHI 110002

AMENDMENT NO. 1 JANUARY 1989
TO
IS : 11185 - 1984 SPECIFICATION AND
TECHNICAL SUPPLY CONDITIONS FOR
HOT-ROLLED AND FORGED STEEL BARS FOR
USE IN MACHINE TOOL INDUSTRY

(*Page 3, clause 0.3, line 3*) — Substitute '55Ni7Cr4 Mo2' for '55Mi7 Cr4Mo2'.

[*Page 3, clause 0.3(b), lines 1 and 2*] — Substitute '40Cr7A110Mo2' for '40Cr1A111Mo2'.

[*Page 3, clause 0.3(c)*]

i) *line 3* — Substitute 'varieties' for 'vareies'.

ii) *line 4* — Substitute '20Ni2Cr2Mo2' for '20NiCrMo2'.

(*Page 6, Table 1*)

i) *col 3, fifth entry* — Substitute '40Ni2Cr1Mo28' for '40Ni2Cr1Mo28'.

ii) *col 3, eleventh entry* — Substitute '50Cr1V23' for '50Cr1V23'.

iii) *col 4, fifth entry* — Substitute '0.35-0.45' for '0.32-0.45'.

iv) *col 10, eighth entry* — Substitute '0.4-0.7' for '0.4-0.10'.

(*Page 8, Table 3*)

i) *col 2, sixth entry* — Substitute 'Blank carburized (refined and quenched)' for 'Black carburized (refined and quenched)'.

ii) *col 6, title* — Substitute the following for the existing title:

'IZOD IMPACT VALUE

J

Min'

(*Page 11, Table 5, Note*) — Substitute '50Cr4V2' for '50CrHV2'.

(*Page 18, clause 14.1.5, line 2*) — Substitute 'freedom' for 'free'.

(SMDC 19)

Indian Standard

SPECIFICATION AND TECHNICAL SUPPLY CONDITIONS FOR HOT-ROLLED AND FORGED STEEL BARS FOR USE IN MACHINE TOOL INDUSTRY

Alloy Steels and Special Steels Sectional Committee, SMDC 19

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Indian Standard

SPECIFICATION AND TECHNICAL SUPPLY CONDITIONS FOR HOT-ROLLED AND FORGED STEEL BARS FOR USE IN MACHINE TOOL INDUSTRY

0. FOREWORD

0.1 This Indian Standard was adopted by the Indian Standards Institution on 31 December 1984, after the draft finalized by the Alloy Steels and Special Steels Sectional Committee had been approved by the Structural and Metals Division Council.

0.2 At present there is no standard for supply conditions of steels required for machine tool industry. There has been a persistent demand from the industry for such a standard to facilitate the procurement of good quality steels required for machine tool production.

0.3 Machine tool industry had in the year 1965 agreed to restrict its requirement of steel to 3 grades, namely, 45C8, 40Ni6Cr4Mo3 and 55Mn7Cr4Mo2. On the basis of experience gained by the machine tool industry, it is now felt that the number of grades should be increased to twelve for the following reasons:

- a) Diversification and expansion of machine tool products in terms of type, grade and accuracy.
- b) Need has been felt to include one nitriding steel, namely 40Cr-1Al1Mo2 which was not covered in the earlier list of 3 steels.
- c) The earlier list of 3 steels contained only one grade of carburising steel, namely, 15Ni7Cr4Mo2 which is quite costly. Three more cheaper varieties of carburising steels, namely, 20MnCr5, 15C8 and 20NiCrMo2 have now been included for more flexibility, choice of steel and to encourage cost reduction when design permits.
- d) The earlier list contained one induction hardening type steel. One more plain carbon induction hardening grade has been added.
- e) Two more grades, one for bearing steel and other for spring steel, have also been added.

0.4 For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS : 2-1960*. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

1. SCOPE

1.1 This standard covers hot-rolled and forged unalloyed and alloyed constructional steel bars required for machine tool industry as raw material.

2. SUPPLY OF MATERIAL

2.1 General requirements relating to supply of material shall conform to IS : 1387-1967†.

2.2 Steels covered by this standard shall be ordered and delivered on any of the following basis:

<i>Requirements</i>	<i>Type of Condition of Delivery</i>						
	A	B	C	D	E	F	G
1. Chemical composition	×	×	×	×	×	×	×
2. Hardness in as supplied condition	×	×	×	×	×	×	×
3. Grain size	—	×	×	×	—	×	×
4. Hardenability	—	—	×	×	—	—	×
5. Mechanical properties in quenched and tempered condition	—	—	—	×	×	—	—
6. Mechanical properties for simulated case-hardened test bar	—	—	—	—	—	×	×

3. CHEMICAL COMPOSITION

3.1 The ladle analysis of steels, when carried out either by the method specified in the relevant part of IS : 228‡ or any other established instrumental/chemical method shall be as given in Table 1. In case of dispute the procedure given in IS : 228‡ and its relevant parts shall be referee method. However, where the method is not given in IS : 228‡ and its relevant parts, the referee method shall be as agreed to between the purchaser and the manufacturer.

*Rules for rounding off numerical values (*revised*).

†General requirements for the supply of metallurgical material.

‡Methods of chemical analysis of steels (*second revision*).

3.2 The check analysis shall be carried out on the finished product. The permissible variation in the case of such check analysis from the limit specified under 3.1 shall be as given in Table 2;

3.3 Elements not specified in Table 1 shall not be added to the steels except where agreed to, other than for the purpose of finishing the heat, and shall not exceed the following limits:

<i>Constituent</i>	<i>Percent, Max</i>
Chromium	0.25
Nickel	0.25
Copper	0.35
Vanadium	0.05
Molybdenum (for through hardening steels only)	0.05

3.3.1 The total of the above elements shall not exceed 0.80 percent.

4. METHOD OF MANUFACTURE

4.1 Unless otherwise specified in the order, the process used in making steel shall be left to the discretion of the manufacturer.

4.2 The steel shall be fully killed.

4.3 Sufficient reduction and discard shall be made from each ingot to secure freedom from piping, harmful porosity, undue segregation and other defects in the bars as supplied. In no case, the reduction from a cast ingot or a continuously cast billet to the final bar size shall be less than six times, for bar size up to 180 mm. For higher sizes reduction ratio may be 4 : 1.

5. HEAT TREATMENT

5.1 Recommended temperatures for hot working and heat treatment for case hardening steels are given in Appendix A.

5.2 Recommended temperatures for hot working and heat treatment for through hardening steels are given in Appendix B.

TABLE 1 CHEMICAL COMPOSITION OF STEELS, PERCENT
(*Clauses 3.1 and 3.3*)

TYPE	STEEL DESIGNATIONS		C	Si	Mn	P, <i>Max</i>	S, <i>Max</i>	Ni	Cr	Mo	OTHERS
	New	Old									
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Heat treatable carbon steels	45C8	C45	0.42-0.50	0.10-0.35	0.6-0.9	0.035	0.035	—	—	—	—
	55C8	C55Mn75	0.5-0.6	0.10-0.35	0.6-0.9	0.035	0.035	—	—	—	—
Heat treatable low alloy steels	40Cr4	40Cr1	0.35-0.45	0.10-0.35	0.60-0.90	0.035	0.035	—	0.90-1.20	—	—
	40Cr4Mo3	40Cr1Mo28	0.35-0.45	0.10-0.35	0.50-0.80	0.035	0.035	—	0.90-1.20	0.20-0.35	—
	40Ni6Cr-4Mo3	40Ni2Cr1-Mo28	0.32-0.45	0.10-0.35	0.4-0.7	0.035	0.035	1.25-1.75	0.9-1.3	0.2-0.35	—
	15C8	G15Mn75	0.10-0.20	0.15-0.35	0.60-0.90	0.035	0.035	—	—	—	—
Case carburizing steels	20MnCr5	20MnCr1	0.17-0.22	0.10-0.35	1.00-1.40	0.035	0.035	—	1.00-1.30	—	—
	20Ni2Cr-2Mo2	20Ni55Cr-50Mo20	0.18-0.23	0.2-0.35	0.7-0.9	0.035	0.035	0.4-0.7	0.4-0.10	0.15-0.25	—
	15Ni7Cr4-Mo2	15Ni2Cr1-Mo15	0.12-0.18	0.10-0.35	0.6-1.0	0.035	0.035	1.5-2.0	0.75-1.25	0.1-0.2	—
	40Cr7Al-10Mo2	40Cr2Al1-Mo18	0.35-0.45	0.10-0.45	0.4-0.7	0.035	0.035	0.3, <i>Max</i>	1.5-1.8	0.1-0.25	Al 0.9-1.3
	50Cr4V2	50Cr1V23	0.45-0.55	0.10-0.35	0.80-1.10	0.035	0.035	—	0.90-1.20	—	V 0.15-0.30
Bearing steel	105Cr5	105Cr1Mn60	0.90-1.20	0.10-0.35	0.40-0.80	0.035	0.035	—	1.00-1.60	—	—
	16Mn5Cr4	17Mn1Cr95	0.14-0.19	0.15-0.35	1.0-1.3	0.035	0.035	—	0.80-1.10	—	—

TABLE 2 PERMISSIBLE VARIATION IN CHECK ANALYSIS

(Clause 3.2)

ELEMENT	PERMISSIBLE CON- TENT IN CAST ANALYSIS, PERCENT	PERMISSIBLE DEVIATION IN PRODUCT ANALYSIS, PERCENT	
		Up to 250 mm ²	Over 250 mm ²
Carbon	Up to 0.25	± 0.02	± 0.02
	0.25 to 0.45	± 0.02	± 0.04
	0.45 to 1.20	± 0.03	± 0.05
Silicon	Up to 0.35	± 0.03	± 0.04
Manganese	Up to 1.20	± 0.05	± 0.07
	1.20 to 1.40	± 0.06	± 0.07
Nickel	Up to 1.00	± 0.03	± 0.05
	1.00 to 2.00	± 0.05	± 0.07
Chromium	Up to 0.8	± 0.03	± 0.04
	0.8 to 2.0	± 0.05	± 0.06
Molybdenum	Up to 0.35	± 0.03	± 0.04
Sulphur	Up to 0.050	± 0.005	± 0.010
Phosphorus	Up to 0.060	± 0.005	± 0.010
Aluminium	Up to 1.3	± 0.10	
Vanadium	Up to 0.30	± 0.02	

6. MECHANICAL PROPERTIES

6.1 Mechanical properties of steels, when heat-treated in accordance with Appendix A and B shall conform to the requirements given in Table 3.

TABLE 3 MECHANICAL PROPERTIES

(Clause 6.1)						
DESIGNATION	CONDITION	TENSILE STRENGTH, N/mm ²	YIELD STRENGTH, N/mm ²	ELONGATION PERCENT, GL 5.65 $\sqrt{A}$, Min	IZOD IMPACT VALUE	LIMITING RULING SECTION, mm
(1)	(2)	(3)	(4)	(5)	(6)	(7)
45C8	Normalized	630-710	345	15	41 35	150
55C8	Normalized	720 Min	395	13	40 35	150
40Cr4	Hardened and tempered	700-850 800-950 900-1 050	540 600 700	18 16 15	55 55 55	100 63 30
40Cr4Mo3	Hardened and tempered	700-850 800-950 900-1 050 1 000-1 150	540 600 700 800	18 16 15 13	55 55 55 48	150 100 63 30
40Ni6Cr4Mo3	Hardened and tempered	900-1 050 1 000-1 150 1 100-1 250 1 200-1 350	700 800 880 1 000	15 13 11 10	55 48 41 30	150 100 63 30
15C8	Black car- burized (refined and quenched)	500-700	350	17	55	30
20MnCr5	do	990 Min	700	8	38	30
20Ni2Cr2Mo2	do	880 Min 780 Min 730 Min	650 600 550	11 — —	40 — —	30 60 90

16Mn5Cr4	Blank car burized (refined and quenched)	800 Min	600	10	35	—
15Ni7Cr4Mo2	Blank car- burized (refined and quen- ched)	1 100 Min	800 Min	9	35	—
40Cr7A110Mo2	Refined and quenched	710-870 790-940 870-1 020	540 600 690	17 15 13	55 55 48	150 100 63
50Cr4V2	Hardened and tempered	850-1 000 900-1 000 1 000-1 200	650 700 800	12 11 9	— — —	150 100 63

NOTE — Mechanical properties for 105Cr5 are not required.

7. HARDNESS

7.1 Hardness of steels in as supplied condition shall be as given in Table 4.

**TABLE 4 HARDNESS IN AS SUPPLIED CONDITION
(SUITABLY HEAT-TREATED)**

STEEL DESIGNATION	HARDNESS, HBS	
	<i>Min</i>	<i>Max</i>
45C8	170	210
55C8	170	220
40Cr4	170	220
40Cr4Mo3	170	220
15C8	—	140
20MnCr5	170	220
20Ni2Cr2Mo2	170	220
40Ni6Cr4Mo3	180	230
15Ni7Cr4Mo2	170	220
40Cr7Al10Mo2	180	230
50Cr4V2	180	210*
105Cr5	180	210*
16Mn5Cr4	170	210

*In spheroidized annealed condition.

8. HARDENABILITY

8.1 Hardenability values of steels when tested in accordance with IS : 3848-1981*, shall be as given in Table 5, for guidance only.

*Method of end quench test for hardenability of steel (*first revision*).

TABLE 5 JOMINY HARDENABILITY VALUES

(Clause 8.1)

SL No.	STEEL DESIGNATION	AUSTENITIZING TEMPERATURE AND TIME	DISTANCE FROM QUENCH END, mm	HARDNESS HRC	
				Min	Max
i)	45C8	850°C-15'	5	29	48
			9	26	32
ii)	55C8	840°C-15'	5	42	60
			9	28	33
iii)	40Ni6Cr4Mo3	840°C-15'	5	54	60
			9	53	59
			25	44	57
				Typical values	
iv)	40Cr7Al10Mo2	870°C-15'	5	54	—
			9	53	—
			25	46	—
v)	40Cr4	900°C-15'	5	50	60
			9	44	58
			25	27	42
vi)	15Ni7Cr4Mo2	900°C-15'	5	38	46
			9	35	45
			25	26	40
vii)	20Ni2Cr2Mo2	900°C-15'	5	32	44
			9	23	35
			25	20	24
viii)	40Cr4Mo3	850°C-15'	5	52	61
			9	50	60
			25	35	53
xi)	20MnCr5	870°C-15'	5	36	45
			9	31	44
			25	21	35

NOTE — Hardenability values for 50CrHV2 and 105Cr5 grade steels are not required.

9. DIMENSIONAL TOLERANCE**9.1 Hot Forged**

9.1.1 Round Bars — Permissible deviation in size for forged round bars shall be as given below:

<i>Diameter Deviation</i>	
Diameter, mm	Tolerance on Diameter
50 to 75	+3 0
75 to 125	+5 0
125 to 175	+8 0
175 to 275	+12.5 0
Over 275	+16 0

9.1.2 Square Edged Flats — Permissible deviation in size for forged flat square shall be as given below:

Width of Flats, mm	Tolerance on Width, mm	Tolerances, mm, or Thickness for Different Specified Thickness, mm		
		12.5 to 25	Over 25 up to and Including 50	Over 50
Over 30 up to and including 50	+3.0 0	+2.0 0	+3.0 0	—
Over 50 up to and including 100	+6.0 0	+4.0 0	+4.0 0	+5.0 0
Over 100 up to and including 150	+8.0 0	+5.0 0	+5.0 0	+6.0 0
Over 150 up to and including 250	+12.5 0	+5.0 0	+6.0 0	+6.0 0
Over 250 up to and including 400	+25.0 0	+6.0 0	+8.0 0	+8.0 0
Over 400	+25.0 0	+6.0 0	+8.0 0	+8.0 0

9.1.3 Straightness and Twist Tolerance

9.1.3.1 The permissible deviation in straightness for forged products shall be 3 mm in any 1.0 metre length.

9.1.3.2 Radial twist more than 3° measured over 1 metre of bar shall not be permitted.

9.2 Hot-rolled Bars

9.2.1 Round and Square Bars — Permissible deviation in size for hot-rolled round and square bars shall be as given below:

<i>Normal Size, mm</i>		<i>Tolerance</i>	
Over	Up to	Permissible Deviation	Out of* Round or Square
—	8	± 0.5	0.5
8	11	± 0.5	0.5
11	15	± 0.5	0.5
15	22	± 0.5	0.5
22	25	± 0.5	0.5
25	28	± 0.75	0.75
28	31	± 0.75	0.75
31	34	± 0.75	0.75
34	38	± 0.75	0.75
38	50	± 0.75	0.75
50	64	± 1.0	1.0
64	80	± 1.0	1.0
80	89	± 1.25	1.25
89	100	± 1.25	1.25
100	114	± 1.5	1.5
114	125	± 1.5	1.5
125	139	± 2.0	2.0
139	160	± 2.0	2.0
160	164	± 2.5	2.5
164	200	± 2.5	2.5

NOTE — In case of square bars, the difference between the two diagonals shall not be more than 1.0 mm.

*Out of roundness is the difference between maximum and minimum diameters of the bars, measured at the same cross-section.

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9.2.2 Hexagonal Bars — Permissible deviation in size for hot-rolled hexagonal bars shall be as given below:

Normal Size, mm		Tolerances, mm	
Over	Up to	Permissible Deviation in Size	Out of* Hexagon
—	13	± 0.5	0.75
13	25	± 0.5	0.75
25	38	± 0.8	1.2
38	50	± 0.8	1.2
50	65	± 1.6	2.4
65	85	± 1.6	2.4

9.2.3 Flats — Permissible deviation in size for hot-rolled flats shall be as given below:

Normal Size, mm		Tolerances, mm			
Over	Up to	On Width	On Thickness		
			6 to 13 including	Over 13 to 25 including	Over 25 to 50 including
—	25	± 1.0	± 0.5	± 0.8	± 1.0
25	50	± 1.0	± 0.5	± 0.8	± 1.0
50	100	± 2.0	± 0.5	± 1.0	± 1.5
100	150	± 3.0	—	—	± 2.0

9.3 Straightness and Twist Tolerance

9.3.1 The permissible deviation in straightness for hot-rolled product: shall be 3 mm in any 1.0 metre length.

9.3.2 Radial twist more than 3° measured over 1 metre of bar shall not be permitted.

9.4 The depth of decarburization when measured in accordance with IS 6396-1971† on any other method as agreed to between the manufacturer and the purchaser shall not exceed the limits given in Tables 6 to 8.

*Out of hexagon is greatest difference between any two dimensions at the same cross-section between opposite faces.

†Methods of measuring decarburized depth of steel.

**TABLE 6 MINIMUM ALLOWANCE PER SIDE FOR MACHINING AND
MAXIMUM DECARBURIZATION LIMITS FOR ROUNDS,
HEXAGONS AND OCTAGONS**

(Clause 9.4)

SPECIFIED SIDE	DIMENSIONS, mm	
	Forged	Hot-rolled
Up to and including 13	—	0·41
Over 13, up to and including 25	—	0·79
Over 25, up to and including 50	1·83	1·22
Over 50, up to and including 75	2·39	1·60
Over 75, up to and including 100	3·05	2·24
Over 100, up to and including 125	3·68	2·84
Over 125, up to and including 150	4·30	3·81
Over 150, up to and including 200	5·08	5·08
Over 200	5·08	—

NOTE — Maximum decarburization limit is 80 percent of machining allowances per side.

10. FREEDOM FROM DEFECTS

10.1 The material shall be free from internal and external surface defects. The defects shall be tested by physical inspection, ultrasonic method and macro-etch method.

10.2 The material shall be free from surface cracks, seams and laps which may be harmful for the end products.

10.3 When macro-etched in 1 : 1 HCL at 65-75° C, the samples shall be free from harmful porosity, slag inclusions, harmful dendritic structure, segregation and cracks.

11. MICRO STRUCTURE

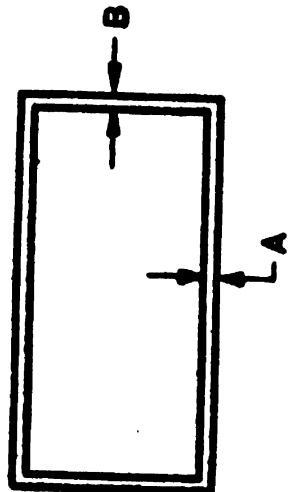
11.1 The micro structure should consist of uniformly distributed ferrite and pearlite, and should be free from harmful banding. The permissible extent of banding shall be mutually agreed to between the purchaser and the supplier.

TABLE 7 MINIMUM ALLOWANCES PER SIDE FOR MACHINING AND MAXIMUM DECARBURIZATION LIMITS FOR HOT-ROLLED SQUARE AND FLAT BARS

(Clause 9.4)

All dimensions in millimetres.

SPECIFIED THICKNESS



MINIMUM MACHINING ALLOWANCE,
SPECIFIED WIDTH

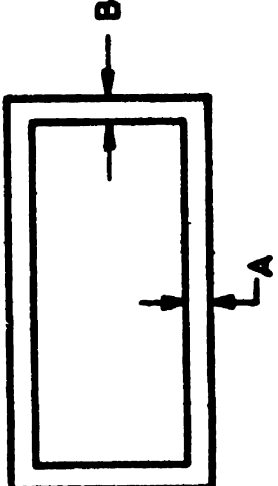
	Up to and in- cluding 13	Over 13 up to and includ- ing 25	Over 25 up to and includ- ing 50	Over 50 up to and includ- ing 75	Over 75 up to and includ- ing 100	Over 100 up to and includ- ing 125	Over 125 up to and includ- ing 150	Over 150 up to and includ- ing 175	Over 175 up to and includ- ing 200	Over 200 up to and includ- ing 225	Over 225 up to and includ- ing 300-
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Up to and including 13	A } B }	0.60 0.60	0.80 1.00	0.90 1.20	1.00 1.40	1.10 1.70	1.27 2.00	1.40 2.10	1.50 2.50	1.50 2.50	1.50 3.00
Over 13 up to and including 25	A } B }	— —	1.10 1.30	1.10 1.50	1.30 1.80	1.40 2.00	1.60 2.60	1.80 2.90	1.90 3.10	1.90 3.20	1.90 3.40
Over 25 up to and including 50	A } B }	— —	1.60 1.60	1.60 1.80	1.80 1.90	1.80 2.30	1.90 2.70	1.90 3.10	2.00 3.50	2.20 3.80	2.30 3.90
Over 50 up to and including 75	A } B }	— —	— —	2.00 2.00	2.00 2.30	2.20 2.60	2.20 3.00	2.30 3.50	2.30 3.90	2.50 4.10	2.50 4.30
Over 75 up to and including 100	A } B }	— —	— —	— —	2.50 2.50	2.50 2.90	2.70 3.10	2.90 3.80	3.00 4.20	3.20 4.20	3.20 3.50

Note — Maximum decarburizing limit is 80 percent of machining allowance per side.

TABLE 3 MINIMUM ALLOWANCES PER SIDE FOR MACHINING AND MAXIMUM DECARBURIZATION LIMITS FOR FORGED SQUARE AND FLAT BARS

(Clause 9.4)

All dimensions in millimetres.

SPECIFIED THICKNESS	SPECIFIED WIDTH									
	Over 25	Over 50	Over 75	Over 100	Over 125	Over 150	Over 175	Over 200	Over 225	Over 250
	Up to and including 50	Up to and including 75	Up to and including 100	Up to and including 125	Up to and including 150	Up to and including 175	Up to and including 200	Up to and including 225	Up to and including 250	
	Over 13 up to and including 25	Over 25 up to and including 50	Over 50 up to and including 75	Over 75 up to and including 100	Over 100 up to and including 125	Over 125 up to and including 150	Over 150 up to and including 175	Over 175 up to and including 200	Over 200 up to and including 225	Over 225 up to and including 250
	A B	A B	A B	A B	A B	A B	A B	A B	A B	A B
Over 13 up to and including 25	1.52 1.83	1.65 2.13	1.65 2.54	1.90 3.05	2.03 3.66	2.16 4.27	2.29 5.08	2.54 5.08	2.79 5.08	
Over 25 up to and including 50	2.29 2.29	2.29 2.54	2.29 2.74	2.54 3.15	2.79 3.76	2.92 4.37	3.18 5.08	3.56 5.08	3.81 5.08	
Over 50 up to and including 75	— —	3.05 3.05	3.05 3.45	3.18 3.56	3.30 3.76	3.43 4.37	3.81 5.08	4.06 5.08	4.44 5.08	
Over 75 up to and including 100	— —	— —	3.81 3.81	3.81 3.81	4.06 4.06	4.57 4.57	5.08 5.08	5.33 5.33	5.72 5.72	
Over 100 up to and including 125	— —	— —	— —	4.57 4.57	4.57 4.57	4.83 4.83	5.33 5.33	5.72 5.72	6.35 6.35	
Over 125 up to and including 150	— —	— —	— —	— —	5.33 5.33	5.72 5.72	5.72 5.72	6.35 6.35	6.35 6.35	
Over 150	— —	— —	— —	— —	— —	6.35 6.35	6.35 6.35	6.35 6.35	6.35 6.35	

NOTE — Maximum decarburization limit is 80 percent of the machining allowance per side.

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12. INCLUSION RATING

12.1 The non-metallic inclusions shall not exceed grade 3A, 3B, 3C and 3D thin series and 2A, 2B, 2C and 2D thick series when tested in accordance with IS : 4163-1967*.

13. GRAIN SIZE

13.1 Austenite grain size shall be between 5-8 when measured in accordance with IS : 2853-1964†. The grain structure shall be considered satisfactory if at least 70 percent is within the specified grain size limits and 30 percent within one size higher or lower than specified.

13.1.1 *Macquaid Ehn Method* — for steel suitable for carburization.

13.1.2 *Oxidation Method or Any Other Standard Method* — for through hardening steels.

14. BASIS FOR ORDER

14.1 While placing an order for steel, the purchaser should specify clearly the following information depending upon their requirement. The properties mentioned by the purchaser should be guaranteed by the manufacturer/supplier and they should provide a test certificate confirming the required properties.

14.1.1 Chemical composition of grade of steel.

14.1.2 *Size*

14.1.3 *Condition of Supply* — Annealed/Normalized/as rolled or forged.

14.1.4 *Mechanical Properties* — Hardness, tensile strength, yield strength, elongation and impact strength.

14.1.5 *Metallurgical Properties* — Austenitic grain size, hardenability values, inclusion rating, microstructure and free from internal defects.

*Determination of inclusion content in steel by microscopic method.

†Method of determining austenitic grain size of thermostat metals.

APPENDIX A

(Clauses 5.1 and 6.1)

RECOMMENDED TEMPERATURE FOR HOT WORKING AND HEAT TREATMENT OF CASE HARDENING STEELS

DESIGNATION	HOT WORKING TEMPERATURE, °C	CARBURIZING TEMPERATURE, °C	SOFTENING Temperature, °C	DOUBLE QUENCH TEMPERATURE Core Hardening, °C	Case Hardening, °C	SINGLE QUENCH TEMPERATURE, °C	QUENCHING MEDIUM	TEMPERING TEMPERATURE, °C
15Ni7Cr4Mo2	1 150-900	900-930	630-650	*A, F	780-820	800-830	0 or salt bath at 180°C	180-200
20Ni2Cr2Mo2	do	880-920	650-660	*A, F	780-820	800-830	do	180-200
20MnCr5		850-890	650-680	*A, F	810-840	810-840	Oil	180-200

*A = Air and F = Furnace,
†O = Oil

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APPENDIX B

(Clauses 5.2 and 6.1)

**RECOMMENDED TEMPERATURE FOR HOT WORKING AND HEAT
TREATMENT OF THROUGH HARDENING STEELS**

DESIGNATION	HOT WORKING TEMPERATURE, °C	AUSTENITIZING TEMPERATURE, °C	QUENCHING MEDIUM FOR HARDENING	TEMPERING	
				Low Tempera- ture 180-200	High Tempera- ture 530-670
45C8	1 100-850	830-860	Water or oil	180-200	530-670
55C8	1 100-850	810-840	Water or oil	180-200	550-660
40Ni7Cr4Mo3	1 200-900	830-850	Oil	180-200	550-660
40Cr7Al11Mo2	1 150-850	880-920	Oil	—	570-650
40Cr4	1 200-850	850-880	Oil	—	570-650
40Cr4Mo3	1 200-850	850-880	Oil	—	550-700
50Cr4V2	1 050-850	850-880	Water or oil	—	550-720
105Cr5	1 100-850	850-880	do	—	540-680
(Nitriding temperature 500-520)					

(Continued from page 2)

**Ad-hoc Panel for Hot-rolled and Forged Steel Bars for Use in
Machine Tool Industry, SMDG 19 : AP**

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